*CIVE 565 – Urban Eco-Hydraulics*

Final Exam Instructor: Montalto

Winter 2019

**For this exam, you are welcome to use any and all resources available on the course website on Drexel Learn. Each student prepares her/his own responses. The purpose of this exam is for each student to demonstrate their mastery of SWMM and its use. Full credit cannot be given for correct answers without justification, or for screen shots in which the answer is not clear. List any and all assumptions you make and be sure to include appropriate units for your answers.**

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**Problem Statement**

A group of your politically-engaged neighbors attended a community meeting organized by the Philadelphia Water Department and learned a few things about green infrastructure. One evening, back on the block, a group of them were talking about how interesting it would be to have one piece of green infrastructure on your block, right when you pass them by on the street.

Knowing that you are an engineer with background and skills in this field, they offered to raise funds to pay you to perform a simple analysis to determine how effective green infrastructure could be in reducing both annual runoff, and runoff during a 10 year, two hour storm on your block. They are interested in a retrospective analysis using historical data and an analysis of future, considering climate-change.

Fresh out of urban ecohydraulics class, you agree to perform this analysis, and to provide them with some rough numbers to take to PWD in support of a pilot project (or not). (Note: they grant you “modeler’s license” – meaning that know that you will need to make some assumptions since they are not paying you to do any field data collection. You agree to do that responsibly. I repeat nobody expect you to go outside to make any measurements. You are simply using the modeling tool you just learned to give your neighbors your recommendation as to how effective a GI solution could be.)

The procedure you set out for yourself is as follows:

1. Obtain an aerial photograph of your block from google, bing, or other such search engine. Use the snipping tool on your computer to convert it into a jpg file.
2. Load the image into a SWMM file (you can scale it if you want to, but that’s not necessary – they key is that I can see the subcatchments on top of the aerial).
3. Set up a model of your block, including the streets, sidewalks, and properties on either sides of the street (which you will assume all drain to the same outlet). Do not waste time with unnecessary details.
   1. Your model must include at least one subcatchment (but you can have as many as you need)
   2. Use the online planimeter: <https://acme.com/planimeter/> to determine approximate lengths and areas as necessary
   3. Use this online topographic map: <http://en-us.topographic-map.com/places/Philadelphia-1587306/> to get a rough idea of the slopes
   4. For infiltration, assume a sandy loam soil
   5. Establish other subcatchment properties per the protocol you learned this term
   6. Your model must also include at least two nodes *downstream of the future GI site* and at least one conduit (but you can have more if you want to). Assume that all conduits are 12 inch diameter smooth circular concrete pipe, installed at 1% slopes. Also assume that the shallowest node in the model has an invert that is 10 feet below the street surface, with the conduit inverts installed 0.5 feet above the node bottoms (creating a sediment sump). Assume no baseflow in the pipe.
   7. The outfall is assumed to be free
   8. Assume that the water table is much more than 10 feet below the ground (e.g. no aquifer is needed)
4. Add philadelphia’s monthly evaporation to the model (given)
5. Add precipitation data to the model so that you can run both:
   1. A one year continuous simulation using hourly precipitation in Philadelphia in 2014 (given)
   2. An event-based simulation at 5 minute time steps (10 year, 2 hour storm is 2.62 inches – use the distribution provided in HW #1)
6. Prepare the first set of deliverables (Deliverable Set #1):
   1. A one paragraph description of the block- Include a map
   2. A half page text description of how you decided to set up your model. In addition to the text description, include one table for all elements you added to your model, with separate columns entitled “parameter”, “value”, “source/justification for parameter selection”. This is where you explain how you picked the parameter values. If you use default values, you need to explain why the default values are appropriate. You can’t just say “used the default value)
   3. A figure showing your model on top of the aerial photograph
   4. A copy of SWMM’s status report after your conducted the continuous model run
   5. A copy of the SWMM’s status report after you conducted the event-based simulation
7. Now you need to decide what type of green infrastructure to install. There is no right answer here, but it needs to be something that is logical and reasonable (in other words, you can’t put in a bioretention facility that would take up the whole street, for example).
8. Design the green infrastructure as an LID control, and decide how you will incorporate it into the model.
9. Use SWMM-CAT to develop the climate adjustments for your zip code. Use far term, medium change conditions.
10. Prepare the next set of deliverables (Deliverable Set #2)
    1. Prepare a one paragraph description/justification of the green infrastructure strategy you developed. Using the site map prepared in deliverable set 1a, conceptually show where the GI system you designed will go (with a rectangle, circle, etc).
    2. Create a table of all of the LID control parameters in the surface, soil, storage, and drain layers, with the same columns as listed above (“parameter”, “value”, “source/justification for parameter selection”)
    3. Include a screenshot of the LID usage editor so I can see the details of how the LID control was added to the subcatchment.
    4. Include a screenshot of the Climatology editor with the adjustments for temperature, evaporation, and rain shown.
11. Now perform your simulations, and prepare the following deliverables (Deliverable Set #3):
    1. Continuous simulation results:
       1. Cumulative runoff versus date plot with separate series on one chart as follows:
          1. Cumulative precipitation over the study area
          2. Cumulative discharge (inflow into the outfall) for the baseline condition
          3. Cumulative discharge for the proposed condition
          4. Cumulative discharge for the baseline condition, with climate change
          5. Cumulative discharge for the proposed condition, with climate change
       2. One table with SWMM’s summary report results for all 4 of the series described above
    2. Event-based simulation
       1. Hydrographs (cfs versus date/time for one day only) showing the following on one chart:
          1. Baseline condition hydrograph
          2. Proposed condition hydrograph
          3. Baseline condition hydrograph with climate change
          4. Proposed condition hydrograph with climate change
       2. One table with SWMM’s summary report results for all 5 of the series described above
    3. Interpretation and Recommendation (Deliverable Set #4)– a one page summary of what you found, what it means, and what you recommend. In this one page report, be sure to discuss the following:
       1. What are the main sources of uncertainty in your analysis, and what other data sets would you ideally need to pursue to reduce that uncertainty?
       2. How did the proposed GI approach alter the block’s annual water budget?
       3. By how much did the proposed GI approach reduce the peak discharge during the 2 yr, 2 hr storm?
       4. Can climate change be expected to “erase” any benefits obtained through greening the block? Why or why not?

Assemble Deliverable Sets 1-4 into a report, add a cover letter in which what you did, what you found, and what it means is concisely described in one paragraph, and submit this to BB learn along with:

* An executable version of your model and backup files
* A statement telling me everything I need to know about how your group worked together. In it you can say, “everyone contributed equally” or “there was a problem” (and then tell me about it).